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13. ABSTRACT *(Maximum 200 words)*
A prototype computer-based training (CBT) system was developed to investigate the effectiveness of applying interactive, 3-D graphics techniques to teach Render Safe Procedures (RSPs) for Explosive Ordnance Disposal (EOD). The EOD Graphical Trainer (EOD-GT) prototype combines conventional multimedia computer based instruction with interactive manipulation of the ordnance in a 3-dimensional graphical environment to provide the student with opportunities to engage the ordnance and hands-on practice of RSP procedures. The prototype EOD-GT focuses on the SUU-25 airborne dispenser and was installed at the U.S. Navy Explosive Ordnance Disposal School for evaluation. Development of the system and future directions are discussed in this report.

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Foreword

This exploratory development effort was conducted under program element 0602233N (Education and Training), project work unit RM33T29, task 12 (Graphical Environments for Training Explosive Ordnance Disposal). It was sponsored by the Office of Naval Research as part of the U.S. Navy's Exploratory Development effort. The primary objective of this research was to develop guidelines for identifying Explosive Ordnance Disposal School requirements for enhanced training support and methods for addressing these requirements. A second objective was to develop a prototype computer based training system that would incorporate advanced interactive graphics technology for enhanced student response.

This report is directed to training communities seeking to evaluate Graphical Environments and Instructional Design as an interactive 3-dimensional environment for individual or team training. This effort recognizes the contributions from the Navy Explosive Ordnance Technical Division, Indian Head, MD.

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Summary

Background

The disposal of unexploded ordnance is an exacting task requiring strict adherence to established procedures and protocols. With thousands of known ordnance items and an unlimited array of improvised devices, the training of the Explosive Ordnance Disposal (EOD) technician is critical. EOD technicians in the field must maintain their level of expertise in disposal of ground, sea, and air munitions while staying current with new ordnance items and procedures. However, EOD skills are only used intermittently. Any replication of an EOD training environment must have enough realistic detail for the development of skills for individuals who will have to operate effectively in complex and stressful environments. Computer-based training (CBT) that incorporates virtual interactive graphics in a three-dimensional (3-D) system promises to improve EOD training effectiveness, as well as provide realistic refresher training to EOD personnel in the field.

Objectives

The primary objective of this research was to develop guidelines for identifying Explosive Ordnance Disposal school requirements for enhanced training support and methods for addressing these requirements. A second objective was to develop a prototype computer based training system that would incorporate advanced interactive graphics technology for enhanced student response. A prototype of the Explosive Ordnance Disposal Graphical Environment Trainer (EOD-GET) built upon the techniques and infrastructure developed at Research Triangle Institute (RTI) would (1) provide a viable training tool for teaching ordnance disposal procedures for a particular ordnance item; and, (2) provide a research test bed for evaluating CBT effectiveness in this domain. A major requirement for the EOD-GET system was that it actively engage the student and maintain the student's interest. Training based on interactive graphics will enable EOD students to practice more frequently, measure increases in skills, and develop a higher "survival" confidence level.

Approach

Development of EOD-GET was divided into four tasks: determine the EOD training requirement, select the ordnance item for the prototype EOD trainer, develop specifications for the prototype EOD trainer, and create and demonstrate the prototype EOD trainer. The accomplishment of each task is discussed in detail. Subject Matter Experts (SMEs) from the Navy EOD School established the criteria for coverage of subject matter, completeness and accuracy of the prototype training materials, level of presentation, engagement of student participation, and use of Virtual Reality (VR) interaction.

Discussion and Recommendations

The initial prototype was successfully completed and installed for pilot testing at the U.S. Navy EOD School in Indian Head, Maryland. As such, the EOD-GET achieves its objective as a prototype system that demonstrates the use of interactive 3-D graphics to enhance the teaching of EOD procedures. At the current stage of development EOD-GET is a prototype system. It is expected that further development will see the system emerge as a fully functional and fully

featured training system. Several possibilities of the system's future use have arisen during installation of the prototype. Explosive Ordnance Disposal training is a prime candidate for implementation with state of the art classroom technology. The deployment of the EOD-GET prototype at the EOD School will provide useful information to guide the future development of this type of training system.

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Introduction

The U. S. Navy is the executive agent in DOD for the training and support of Explosive Ordnance Disposal (EOD) personnel. The Naval EOD School and EOD Technology Center support all services, as well as the FBI, Secret Service, and other agencies. The disposal of unexploded ordnance items is an exacting task requiring strict adherence to established procedures and protocols. With over 6000 known ordnance items and an unlimited array of improvised devices, the training of EOD personnel is critical. EOD trainees must become well-versed in the principles of operation and disposal of ground, sea, and air munitions, and EOD personnel in the field must maintain their level of expertise while staying current with new ordnance items and procedures.

The use of computer-based training (CBT) incorporating interactive 3-D graphics promises to improve EOD training through reduced cost, increased capability, ungradability, and greater training effectiveness . A graphical environment with three-dimensional visualization could allow personnel to safely learn the design of ordnance pieces, as well as the best procedures to disarm the ordnance. Graphical displays should reduce the costs associated with training ordnance, supervision, and range safety. Supervisory costs are high because of the low student to instructor ratio required for this kind of training. Training based on interactive graphics would enable EOD students to practice more frequently, measure increases in skills, and develop a higher "survival" confidence level.

A prototype of the Explosive Ordnance Disposal Graphical Environment Trainer EOD-GET built upon the techniques and infrastructure developed at Research Triangle Institute (RTI) for previous CBT systems for the M1 Abrams tank and the Paladin mobile howitzer would (1) provied a viable training tool for teaching disposal procedures for a particular ordnance item, and (2) provide a research test bed to evaluate CBT effectiveness in this domain. The prototype was successfully completed and installed for pilot testing at the U.S. Navy EOD School at Indian Head, Maryland.

Approach

Development of EOD-GET was divided into four tasks as follows:

A. Determine EOD Training Requirements
B. Select the Ordnance Item for the Prototype EOD Trainer
C. Develop Specifications for the Prototype EOD Trainer
D. Create and Demonstrate the Prototype EOD Trainer

The accomplishment of each task is discussed in detail below.

Task A: Determine EOD Training Requirements

Through a series of meetings held at the EOD School, the EOD Technical Publications Division, and at RTI, the training requirements for the EOD-GET system were defined. One possible application for the training system was determined to be a self-study module focusing on

one particular ordnance item. The system will likely be employed in the independent night study phase of EOD training. Students are expected to complete 2-4 hours of self study each night while enrolled in the course. During this period, students are expected to supplement classroom instruction by reviewing publications pertaining to ordnance items not covered in the classroom. Students typically receive no more than 10 minutes of classroom instruction on most of the ordnance items covered during the lecture phase, so night study is an important adjunct to classroom lectures. But, night study often has limited effectiveness since students may quickly lose interest in reading publication after publication. As such, a major requirement for the EOD-GET system is that it actively engage the student to maintain a high level of interest and motivation that will yield effective absorption of the subject matter.

Task B. Select the Ordnance Item for the Prototype EOD Trainer

After defining the requirements for the system, the next step was to choose the ordnance item on which the trainer would focus. EOD School personnel recommended a choice of two aircraft-mounted dispensers: a) the SUU-25 flare dispenser, and b) the SUU-14 bomb dispenser. The technical publications for both dispensers are unclassified, and as such, both were suitable for the demonstration training system. Higher levels of security pose special problems for computer-based training that could severely limit the kinds of hardware that could be used in the prototype.

The SUU-25 flare dispenser was ultimately selected for the prototype EOD-GET system because it had a more complicated render-safe procedure (RSP) than the SUU-14 bomb dispenser. A more complicated RSP would be more challenging to implement in a virtual environment, and would provide a more powerful example of the effectiveness of virtual environment techniques in EOD training.

Task C. Develop Specifications for the Prototype EOD Trainer

Curriculum

Once the specific ordnance item was selected, work began on the development of training specifications for the EOD-GET system. Project personnel reviewed the relevant technical publications for the SUU-25, including TM-60C-2-2-28-1, and the associated Instructor Guides used in classroom instruction. The Instructor Guides provided guidance about airborne dispensers in general, and on the SUU-25 family in particular. It is important to remember that EOD training centers around generic instruction on a family of ordnance items, with more detailed instruction on a small subset of items in the family. The idea behind this approach is that the items in an ordnance family will share many functional characteristics.

The publications review yielded a comprehensive curriculum for the EOD-GET comprising eight lessons that covered all information pertinent to rendering safe and disposing of a SUU-25 dispenser. For each lesson, detailed narratives were written that explicitly defined the interaction between the student and the prototype training system. The lesson narratives were reviewed by NPRDC personnel and Naval EOD School instructors for completeness and accuracy.

The eight lessons making up the EOD Trainer are as follows:

Lesson 0:	Course overview
Lesson 1:	Guided tour of SUU-25
Lesson 2:	Reconnaissance
Lesson 3:	Introduction to Virtual Reality (VR)
Lesson 4:	Render-safe procedure
Lesson 5:	Unloading procedure
Lesson 6:	Disposal procedure
Lesson 7:	Final exercise

Each of these lessons are described in detail below.

Lesson 0: Course Overview. This lesson provides a brief description of the organizational structure and instructional content of the course. The lesson also reviews mouse manipulation for those users without computer experience. Computers are not an inherent part of the EOD job, and many personnel must be considered to be novice computer users.

Lesson 1: Guided Tour of SUU-25. Lesson 1 presents the information contained in Sections 1-5 of the SUU-25 publication (TM-60C-2-2-281). Two dimensional images are used to illustrate the dispenser's appearance, and animation is used to demonstrate the dynamic aspects of the dispenser's operation. Since this lesson does not require student interaction with modeled dispenser parts, three dimensional representation of the dispenser is not necessary. Therefore, it contains no VR component.

Lesson 2: Reconnaissance. This lesson addresses the aspects of the SUU-25 dispenser that are pertinent to reconnaissance procedures. Reconnaissance is a major component of the EOD job, and consists of number of important steps. These steps include identification of an ordnance item from visual characteristics and markings. EOD personnel must also take the proper safety precautions and determine acceptable approach paths based upon the family characteristics of the ordnance item. All information required by the RECON section of the EOD Problem Solving Work Sheet is presented. Lesson 2 assumes that the student is already familiar with the general concepts and procedures of EOD reconnaissance. It does not attempt to teach these principles, but discusses those aspects specific to SUU-25 that are pertinent to the reconnaissance task.

Lesson 3: Introduction to VR. This lesson introduces the student to the navigation techniques required in the lessons, and a three-dimensional model of the SUU-25 dispenser. The 3-dimensional aspect of the lessons allows students to move the dispenser so it can be observed from any position and to interact with different facets of the model of the dispenser. The model can be manipulated in a variety of ways. Students can rotate the model along any axis, and can zoom the viewpoint in or out. One new feature of the VR interface is an iconic tool bar that represents the tool kit EOD personnel are required to use to complete the render-safe procedures. Students must learn to use the iconic representations as they would the actual tools.

Lesson 4: Render-Safe Procedures. Lesson 4 covers instruction on the render-safe procedures for the SUU-25 dispenser. This is the first lesson in the course to have a VR component. The

VR model is used to allow the student to perform the steps discussed in Sections 6 and 7 of TM-60C-2-2-28-1. As in the publication, the render-safe procedure for the Unarmed condition is covered first, followed by the procedure for the Armed condition. Lesson 4 is actually made up of three parts. The first part of the lesson is a pre-test. If the student successfully passes the pre-test, the student has the option of skipping over the instructional and test parts of the lesson. The second part of the lesson is the instructional component. This part guides the student step by step through the render-safe procedures. The third part of the lesson is post-test. This test requires the student to carry out the render-safe procedure with minimal guidance provided by the instructions taken verbatim from the publication. For example, the system may instruct the student to "Cut the eight leads that connect breech caps to manifold." The student is expected to know how to navigate to the front of the dispenser where the firing leads are accessible, choose the wire cutters from the toolbox, click on a firing lead with the wire cutter tool cursor, and select "Cut" from the subsequent dialog box.

Lesson 5: Unloading Procedures. Lesson 5 covers the unloading of the payload from the SUU-25 dispenser as discussed in Section 8 of the publication TM-60C-2-2-28-1. As with Lesson 4, there is a pre-test part for the student, a guided instructional part, and a post-test part. This lesson uses a VR component to enable the student to carry out the instructions taken from the technical publication. Normal practice in the field usually requires the student to render each payload munitions safe as it is removed from the dispenser. EOD-GET does not cover this aspect of the unloading procedures because the payloads are classified devices.

Lesson 6: Disposal Procedures. Lesson 6 covers the disposal procedures as presented in Section 9 of the publication TM-60C-2-2-28-1. As with the previous lessons, there are three components to Lesson 6, the pre-test, guided instruction, and post-test. Because much of the disposal procedures involved actions that are not easily implemented with a through-the-window type of virtual environment using mouse interaction, this lesson has no VR component. Instead, this lesson was prepared in traditional text with static graphics format.

Lesson 7: Final Exercise. Lesson 7 is the final exercise in which the student demonstrates the ability to carry out the entire set of procedures for safe disposal of the SUU-25 dispenser. This lesson is essentially a concatenation of the test portions of Lessons 4, 5, and 6. A mixture of VR interaction and multiple choice questions are used to evaluate the student (Figure 1).

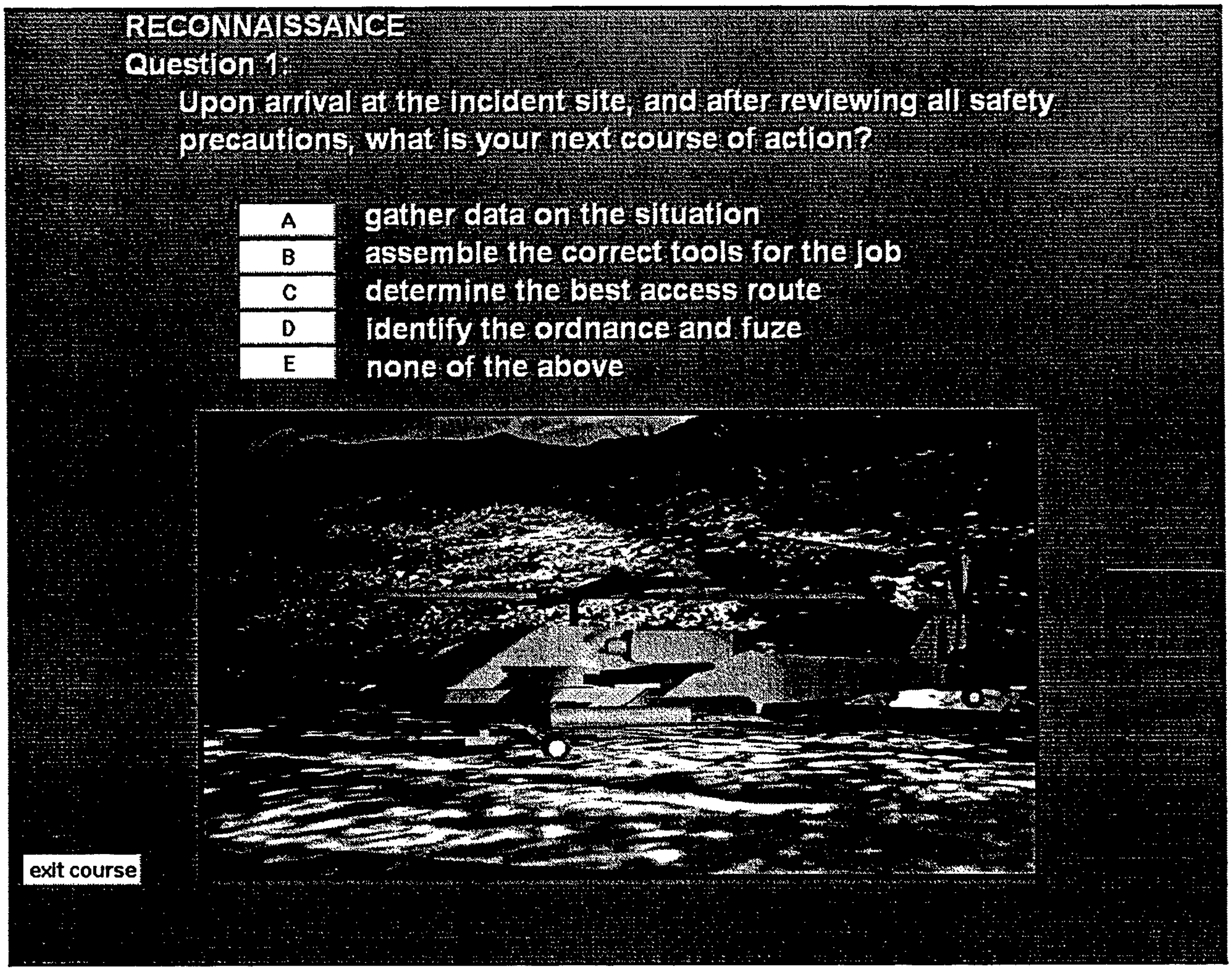

Figure 1. EOD-GET sample screen of test question.

User Interface

Construction of the curriculum and lesson narratives for EOD-GET required defining the user interface. For Lessons 0, 1, 2, and 6, in which no VR interaction is required, the user interface design followed the standard capabilities provided by the multimedia authoring package. For lessons and test questions in which VR interaction is required, the user interface was designed to make optimum use of available screen space, allocating the top third of the screen to the multimedia application and the bottom two-thirds of the screen to the VR window (Figure 2).

Interaction with components of the dispenser is effected by clicking on the component with the left mouse button and then choosing the appropriate function from the popped-up dialog box. The dialog box presents actions appropriate for the selected object. Actions that are not valid are dimmed and unable to be selected by the student. To handle inadvertent object selections, dialog boxes for all objects contain a Cancel button, which will terminate the interaction with no effect.

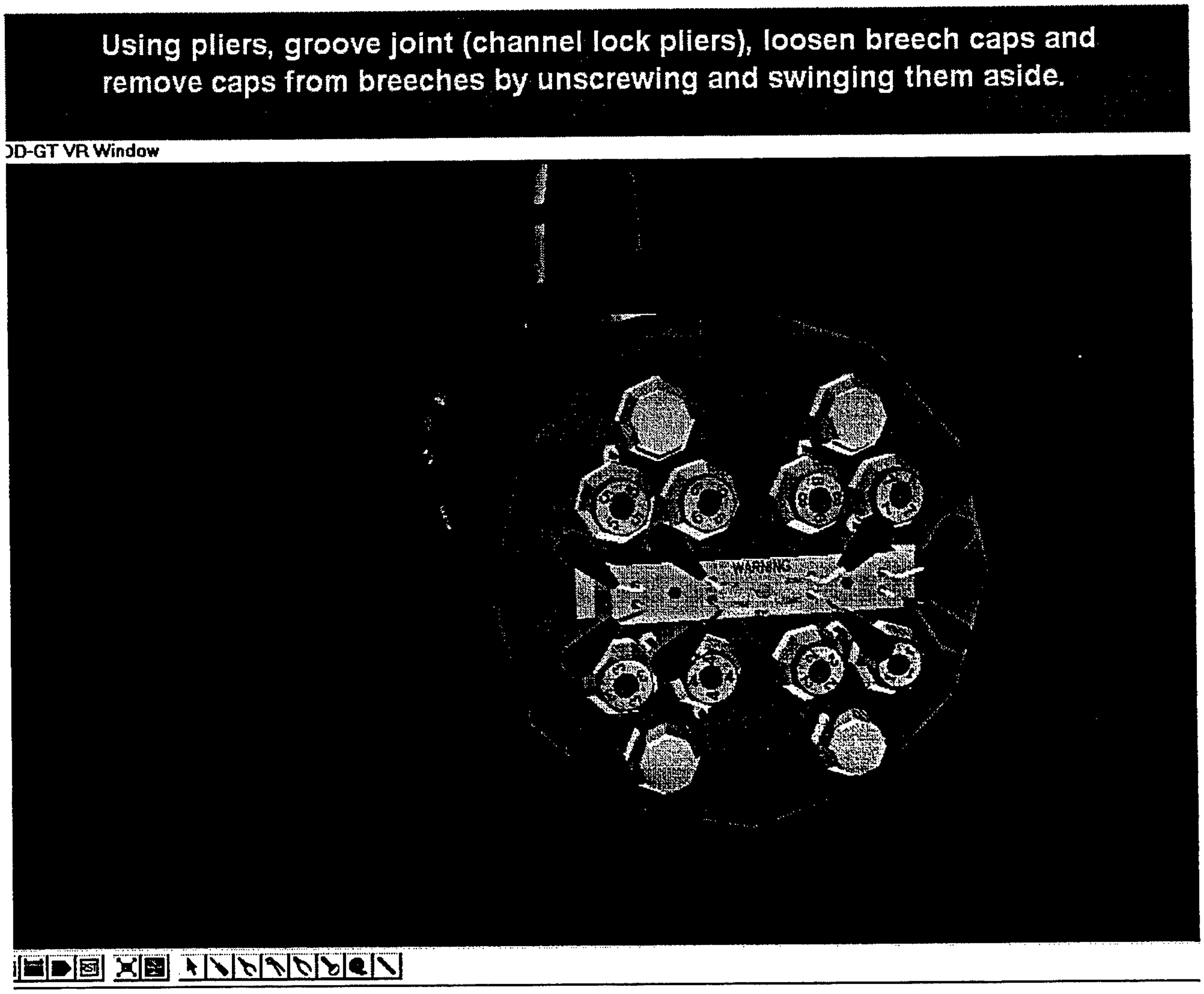

Figure 2. Sample screen showing CBT Authorware window above larger VR window.

Navigation. This VR window provides a dynamic view of the 3-D virtual model of the dispenser, and the student is able to freely navigate about the dispenser and view it from any arbitrary angle. However, in order to reduce the computational overhead of the three dimensional model, changes in the orientation of the dispenser are allowed only in discrete steps instead of continuous variations in orientation.

This free navigation is controlled by the position of the cursor relative to the center of the window when the right mouse button is pressed. The horizontal position of the cursor relative to the window's center determines whether the viewpoint will move to the left or to the right, and distance between the cursor and the window center is directly related to the speed at which the viewpoint moves. Similarly, the up-down movement of the viewpoint is controlled by the vertical position of the cursor relative to the window center.

When the viewpoint moves, in whatever direction, its view is constrained to always keep the dispenser in the center of view. Thus, up-down viewpoint movement can be thought of as the viewpoint moving along the longitude lines of an imaginary globe centered on the dispenser. Left-right viewpoint movement can be thought of as movement along the imaginary globe's latitude lines. As the viewpoint moves it is always looking at the dispenser, located at the center of the globe.

Navigation Buttons. Along the bottom of the VR window is a tool bar containing six buttons that augment the cursor-based navigation described above. Three of the buttons are used to position the center of the globe at different parts of the dispenser. The "rear" button puts the back end of the dispenser at the center of the navigation globe, allowing the student to more easily examine and interact with dispenser components on the back end. Similarly, the "middle" button puts the center of navigation at the middle of the dispenser, providing good access to the side access panels and front retaining links, and the "front" button changes the center of navigation to the front end of the dispenser, enabling manipulation of the firing leads, breech caps and other components. The other navigation buttons provide a "reset" to a default, overall view of the dispenser, and "zoom-in" and "zoom-out" capability.

Toolbox. When performing in the field, EOD personnel must bring with them a toolbox containing tools and other implements needed to perform the render-safe procedure. Indeed, the EOD publications are often quite specific about what tool to use for a certain step (e.g. "Using pliers, long-nose (long-nose pliers), remove shear pins from the four front retaining links."). This toolbox is simulated in the EOD-GET system by a collection of buttons on the tool bar at the lower edge of the VR window (Figure 3). Each button represents a different tool or implement needed for working on the SUU-25 dispenser (screwdriver, long-nose pliers, channel-lock pliers, wire cutters, ammo tape, push rod, shorting pin). When the student clicks on a button and selects a tool, the cursor changes to represent the select tool. The proper tool must be selected for the student to perform the render-safe procedures. For example, a screwdriver must be selected to remove screws. If the screwdriver is not selected, the screws cannot be removed with another tool or the mouse pointer.

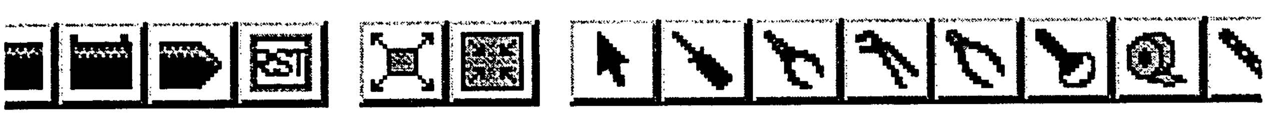

Figure 3. Close-up of VR window tool-bar.

Task D: Create and Demonstrate the Prototype EOD Trainer

The final task in the statement of work for this project was the implementation of the specifications as a working computer-based training system. This task, as defined in the statement of work, was originally planned to proceed in a sequence of four phases:

Phase 1: Analysis of current training materials and methods.

Phase 2: Construction of 3-D computer models and 2-D images and animations as required by Phase I lesson plans.
Phase 3: Translation of lesson plans into multimedia scripts.
Phase 4: Build 3-D graphics lessons.

The development of EOD-GET actually proceeded as several concurrent "threads."

Thread 1: Data collection and model building.
Thread 2: Translation of narratives into computer-based training programs.
Thread 3: Development of VR interaction server.

Data Collection and Model Building

Based on data collected on-site at the Naval EOD School, a detailed 3-D computer model of the SUU-25C/A was built using 3D Studio. The model, consisting of xxxx triangles, contains all parts of the dispenser that must be manipulated as part of disposal, situated on a base object comprising nonmanipulable components, such as the dispenser body, manifold, breeches, and bulkheads. Textures are used to authentically represent important detail, such as warning labels and identification markings.

The computer model of the dispenser served two purposes. First, it was used as input to the VR server, to be explored and manipulated by the student. Second, the model was also used in high-quality renderings to produce 2-D illustrations and animations used in the multimedia programs.

Computer-Based Training Programs

Macromedia Authorware Professional for Windows was the multimedia authoring system used to build the instructional components of the EOD-GET. These components mix text, static and dynamic graphics, interactive objects, and audio images to engage the student and achieve the instructional goals. These constructs are used to both present information to the student, and to solicit input from the student. When testing the student, the EOD-GET provides remedial responses to incorrect student input.

VR Interaction Server

The VR interaction server provides a 3-D interactive interface between the student and the Authorware-based training component of the EOD-GET. The VR interaction server presents the student with an interactive 3-D model of the dispenser, and allows the student to explore and study the dispenser from all angles and to manipulate dispenser components using the mouse. Methods of navigation and interaction are discussed above. The VR server reports student actions to the training process, which then formulates an appropriate response. This response may be a textual response (such as an error notification), progressing to the next step in the training program, or invoking some change in the state of the virtual environment.

VR Server Software Architecture

The software architecture for the VR interaction server comprises four modules: a model loader, an object library, an interaction manager, and an OLE 2 automation server. The *object library* is a collection of object classes, each of which encapsulates the properties and behavior of a particular type of virtual object. For example, one class of objects may be the breech cap and another might be the shear pin. Both breech caps and shear pins can be manipulated by the student. Breech caps must be opened with channel-lock pliers and shear pins must be removed with long-nose pliers. Therefore the definitions of these two classes will both include functions defining the response of the object to being clicked on with the mouse, but the functions will be different. The breech cap function will unscrew the breech cap and then pivot it to the side on its post, but only if the channel-lock pliers tool had been previously selected. The shear pin function will extract the shear pin from its hole and discard it, but only if the long-nose pliers had been previously selected.

This object-oriented design enables objects that are different to have different behaviors that can be modified individually without changing the behaviors of other objects. It also allows similar objects to share behavior when appropriate, which simplifies the task of defining or modifying this shared behavior. The object-oriented approach is well-suited to a prototype system such as the EOD-GET, for it facilitates a rapid prototyping process in which different interactions between the student and the virtual environment can be investigated with minimal effort.

The *model loader* builds the virtual environment from textual description files that define the models to be loaded for each object, the position and orientation of each object, the hierarchy of objects in the virtual environment, and the behavior of the object.

The *interaction manager* monitors mouse and keyboard activity, and when appropriate affects navigation in the virtual environment and object interaction. The interaction manager also reports user activity to the Authorware CBT process through the standard Microsoft Windows messaging facility.

The OLE 2 *automation server* responds to commands from the Authorware training process. The commands originate as the Authorware function calls into an EOD-GET-specific dynamically linked library (DLL). The EOD-GET DLL translates these function calls into commands for the Microsoft OLE 2 automation facility. For example, to start up the VR component for a Lesson, the Authorware process must first execute a "start_server" function call. Once the server is started, the Authorware process will execute more function calls for operations such as loading a certain virtual universe, setting the state of a particular virtual object. These subsequent function calls are passed on to the OLE 2 facility, which invokes the appropriate action in the EOD-GET VR server. In this manner, the training process can control all aspects of the virtual environment seen by the student.

Performance Issues

A major influence in the development of the EOD-GET was the effect each particular feature of the system would have on the overall training experience for the student. For any interactive graphics application two important factors in the success of the system are *update rate* and *latency.* Update rate is the number of times the image on the screen is refreshed in a given amount of time and is usually expressed in frames per second. Latency or lag is the time delay experienced by the

user between the instigation of some interaction, e.g. the pressing of the right mouse button for navigation, and the moment the effect of the interaction can be seen in the display (e.g., the resultant change in view). High update rate and low latency are desirable to increase the sense of presence of the user in the virtual world and to maximize the effectiveness of the direct manipulation. Low update rate and high latency can greatly diminish the sense of directly manipulating objects in the virtual environment, and can frustrate the user.

Model Complexity

The complexity of the models used in the EOD-GET was targeted at the minimum number of polygons that could produce a recognizable representation of the dispenser and its components. More polygons would yield a more veridical model of the dispenser, but would slow down rendering, reduce the update rate, and increase latency. Fewer polygons would enhance performance, but would sacrifice the usability of the model. The SUU-25 model used in the EOD-GET required close to 100 objects to be manipulated, some of which were very intricate. Modeling shortcuts were taken wherever feasible. For example, the cylindrical body of the dispenser was modeled as a 12-sided tube and the shear pins were modeled as small rectangular slabs textured with the image of the shear pin rather than as a thin cylindrical wire bent into a complex shape. Still, the entire model comprises approximately 20,000 polygons--perhaps more than one might expect for an 8-foot long object, but not unreasonable considering the number and complexity of the individual components. The model yields satisfactory performance, which may perhaps be improved through more polygon reduction and judicious reorganization of the model.

Model Behavior

All of the actions required by the render-safe, unloading, and disposal procedures for the SUU-25 require some mechanical manipulation. The fairing must be rotated slightly and then pulled off the front of the dispenser. Breech caps must be unscrewed and pivoted aside. The original design of the EOD-GET called for these mechanical actions to be faithfully reproduced by the virtual model to provide the student with a truer simulation of the experience of working on the dispenser. The models of the breech caps could be animated to reproduce the unscrewing and pivoting motion. After in-progress review by the SMEs, however, it was decided that the update rate of the system was too low to support the object animation. The time required for animation of some repetitive procedures (e.g., unscrewing individual breech caps) was considered detrimental to the training effectiveness of the system. Consequently, the animated sections were streamlined to the minimal number of steps required to show the transition of the object to increase the role of interaction.

Another modification made after review by the SMEs was the consolidation of repeated, tedious actions into one representative action. For example, the process of individually disconnecting each of the eight firing leads was replaced by the single action of disconnecting any one of them, which would then cause the disconnection of all eight leads. This type of streamlining, used also for breech caps, impulse cartridges, shear pins and retaining links, served to maintain a higher level of engagement between the student and the system without sacrificing training effectiveness.

Development Environment

The instructional component of the EOD-GET was developed with Authorware Professional v2.0. The VR interaction server was developed with Microsoft Visual C++ v2.2, with extensive use being made of the Microsoft Foundation Class library. Creation of and interaction with the virtual environment was implemented using WorldToolKit for Windows v2.04 from Sense Corporation.

System Specifications

Originally, the EOD-GET system was to be developed as an interactive training system with the following specifications:

Pentium PC/DOS.
32 MB RAM.
120 Hz multisync monitor.
SPEA Fireboard (graphics accelerator).
Sound board and speakers.
WTK860 (WorldToolKit i860 version).

It soon became clear that such a system would be unsatisfactory for several reasons. The Fireboard was discontinued by SPEA and quickly became scarce. Sense8 ceased development of the WTK860 library, instead focusing its attention on the Windows and SGI versions of WorldToolKit. Running under DOS precluded the tight communication between the Authorware and VR components of the system that was made possible with the OLE 2 facility. To overcome these problems and to be able to supply a superior product, the specification for the target system for the EOD-GET was changed to:

Pentium PC/Windows95.
32 MB RAM.
Super VGA monitor 1024x768.
Sound board and speakers.
WTKWIN v2.04 (WorldToolKit for Windows version).

Discussion and Recommendations

Subject Matter Experts (SMEs) from the Navy EOD School at Indian Head, MD established the criteria for coverage of subject matter, completeness and accuracy of the prototype training materials, level of presentation, engagement of student participation, and use of VR interaction. As such, the EOD-GET achieves its goal as a prototype system that demonstrates the use of interactive 3-D graphics to enhance the teaching of EOD procedures.

At the current stage of development EOD-GET is a prototype system. It is expected that further development will see the system emerge as a fully functional and fully featured training system. A reevaluation of the objectives may be in order. Several possibilities of the system's future use have arisen during installation of the prototype. Explosive Ordnance Disposal training is a prime candidate for implementation with state of the art classroom technology. In addition to use as a night time trainer the EOD-GET system may be designated for classroom use, for remedial

training, training in the field, or field personnel refresher training. The deployment of the EOD-GET prototype at the EOD School will provide useful information to guide the future development of the system.

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